A Textual Processing Model of Risk Communication: Lessons from Typhoon Haiyan

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Abstract. As the world's urban poor increase in numbers, they become acutely vulnerable to hazards from extreme weather events. On November 8, 2013, Typhoon Haiyan struck the province of Leyte, Philippines, with casualties numbering in the thousands, largely due to the ensuing storm surge that swept the coastal communities. We investigate the role and dynamics of risk communication in these events, specifically examining the organizational processing of text within a complex institutional milieu. We show how the risk communication process failed to convey meaningful information about the predicted storm surge, transmitting and retransmitting the same routine text instead of communicating authentic messages in earnest. The key insight is that, rather than focus solely on the verbatim transmission of a scripted text, risk communication needs to employ various modes of translation and feedback signals across organizational and institutional boundaries. Adaptation will require overcoming organizational rigidities in order to craft proportionate responses to extreme weather events that may lie outside personal and institutional memory. Future work should build upon the textual processing model of risk communication.

Keywords: extreme weather, Typhoon Haiyan, storm surge, risk communication, textual processing model

Introduction.

Typhoons and attendant storm surges can be predicted days in advance of their onset. But how should we conceptualize the concomitant risk communication process for extreme weather events? Is it most properly understood as the routinized transmission of parcels of information from sender to receiver along a chain of communication? Or should it be a more active and dynamic exchange, where a variety of narrators tell the story in different ways, interpreting it according to who the speakers and listeners are? As our investigation surrounding Typhoon Haiyan suggests, these questions are among the most urgent and consequential for reducing the impacts of extreme weather on society.

The Intergovernmental Panel for Climate Change (IPCC) suggests that, attendant to anthropogenic influences on global climate, there may be more frequent extreme daily minimum and maximum temperatures, intensification of extreme precipitation, and increasing coastal high water (IPCC, 2012)[1]. IPCC reports note with high confidence that areas of urban and low-lying coastal zones are at the most risk of severe harm and loss from climate change-related hazards (Oppenheimer et al., 2014). Increasingly, communities may undergo extreme weather-related events (e.g., floods) of magnitudes that the local population has never before experienced (Peduzzi et al., 2009; Thomas, Albert, & Hepburn, 2014). Thus, development of effective strategies for adaptation to and communication of these intensifying extreme events is becoming ever more important. The transition from knowledge to action is aided by experiential processing, which requires linking

[1] The extant evidence on increasing tropical cyclone intensity is most reliable for the Norh Atlantic (Grossman and Morgan, 2011; Schiermeier, 2013), and some evidence that this may possibly hold for other ocean areas as well (Emmanuel, 2013).

climate and weather forecast communication to personal and collective memory (Colten and Sumpter, 2008; Akerlof et al., 2013; Hall and Endfield, 2015). Yet sometimes the nature or the magnitude of an extreme weather event lies outside the personal and institutional memories of the affected populace, or only in distant memory (Gaillard et al., 2004; Howe et al., 2014). Especially when unusually extreme events like these are expected, communication of their prediction must be delivered with reference to specific context and recommendations for action.

On November 8, 2013, Central Philippines encountered one of the strongest tropical cyclones to make landfall in recorded history (Schiermeier, 2013; Normile, 2014). Notwithstanding forecasts that warned of wind speeds around 300 kph and a 7 meter storm surge, the devastation was extensive, particularly in Tacloban City in Leyte province, which lay right in the path of the typhoon (see Figure 1) and where most of the fatalities were due to the storm surge.[2] Intensity estimates derived from satellite data just before landfall revealed a maximum 1-minute sustained wind speed of 315 kph, which is a Category 5 on the Saffir–Simpson Scale (Daniell et al., 2013). Post-event field measurements in Leyte revealed storm surge heights of 4 to 8 meters with an average inundation height of approximately 6 m (Mas et al., 2014), proving the surge model prediction to be reasonably accurate. Tacloban City, in particular, exhibits the confluence of social and physical vulnerability described in the hazard-of-place literature (Cutter et al., 2009). The area features a shallow coastal bathymetry that is conducive to storm surge (Soria et al., 2016)

[2] A final count was never achieved, though the government's official estimate is around 6,300 (NDRRMC, 2014), a figure that has been disputed by different sources (Esmaquel, 2013; Avila, 2014; IBTA, 2014).

85 combined with poverty and makeshift or substandard housing[3]. The people and officials in
86 Tacloban should have been ready, yet even the mayor of Tacloban and his family were caught by,
87 and nearly perished in, the storm surge in their beachfront homes (Salaverria, 2013). The national
88 agency's weather monitoring team in Tacloban misinterpreted the storm surge warning and was
89 caught by the surge in their seaside office, resulting in a team member's death (Flores, 2013).
90
91 [Insert Figure 1 around here.]
92
93 One wonders, then, why the reasonably accurate forecasting would not lead to effective risk
94 prevention on the ground? Ex post evaluations suggested many factors to have contributed to the
95 devastating impact of Typhoon Haiyan, but one theme stood out, in particular: the way risks of
96 storm surge were communicated (Rasquinho, 2014; GIZ, 2014). In the words of one of the
97 managers in the national weather service, "It's more on the signals and in delivering the forecasts
98 and warning distributed to the public. But the storm surge wasn't explained there".[4] These and
99 other anecdotal reports implicate risk communication during Typhoon Haiyan as an important
100 object for inquiry.
101
102 Since organizational factors have been implicated in risk communication failures in the past
103 (Freudenburg, 2003; Cole and Fellows, 2008), especially concerning large-scale tropical cyclones

[3] Tacloban has a population of 221,174, as of the 2010 Census, and is growing at 2.16% per year. Only 43.4% of the housing in the municipality is of standard (concrete) construction. Source: http://web0.psa.gov.ph/content/population-tacloban-city-rose-more-200-thousand-results-2010-census-population-and-housing (downloaded December 8, 2014).

[4] http://www.rappler.com/move-ph/issues/disasters/typhoon-yolanda/43735-yolandaph-haiyan-preparedness-philippines (accessed May 22, 2016).

104 and tsunamis, events such Hurricane Katrina and others (Marris, 2005; Cole & Fellows, 2008), our
105 work highlights the risk communication process as it is carried out within a complex organizational
106 structure. We focus most closely on the aspect of institutional translation of risk signals, both
107 within and across organizations. Using the case study of Typhoon Haiyan as an example, we
108 investigate the influence that methods for communicating risk information about an extreme, non-
109 routine weather event have on the response of the population at risk. The Philippines presents an
110 appropriate context for such an investigation, as faulty communication of hazards such as volcano
111 eruptions and typhoons have been implicated in a number of disasters in this country in the past
112 (e.g., Leone and Gaillard, 1999). Recent IPCC reports highlight how tropical coasts and islands
113 are extremely vulnerable in terms of geographic location and response capacity with insufficient
114 government attention on disaster risk reduction (Oppenheimer et al., 2014; Nurse, et al., 2014).
115 Our research highlights the need to reflect critically on the role of organizational routines and inter-
116 organizational processes in risk communication, and the importance of developing effective
117 communication in order to avoid the unnecessary losses experienced during Typhoon Haiyan.
118
119 The idea of adaptation suggests the identification and implementation of measures to respond to
120 risks of extreme events, looking backward at a region's history of such events, as well as forward,
121 trying to discern new emerging patterns of risk and vulnerability. Historically, the Philippines
122 receives more tropical storms than any other country except for China[5], so there is a great
123 awareness regarding typhoons among Filipinos. However, the agencies and the population pay
124 most attention to risks from the high wind speeds and rainfall, more so than storm surges. In fact,
125 there are records that a similarly devastating storm surge occurred in Tacloban City in the past

[5] http://www.aoml.noaa.gov/hrd/tcfaq/E25.html

(Soria et al. 2016). But these infrequent events can be lost from the institutional and personal memories of a region --in the case of Tacloban City, the said storm surge occurred in 1897 (Algué, 1989). Soria et al. recount how residents of Samar and Leyte described their precautionary measures prior to Typhoon Haiyan's arrival were guided mainly by their experience of lesser typhoons (Soria et al., 2016). Moreover, prior to Haiyan, the most cataclysmic weather event in the region was the Ormoc City flood during Tropical Storm Thelma in 1991, but the flooding was due to the excessive rainfall and mud slides, not storm surge (Mahmud, 2000). Adaptation also requires anticipating and preparing for events that have never been experienced by a region's residents. As Soria et al. ask: "How does the experience of smaller, relatively less impactful events shape the response of the community to larger, unprecedented events or those with return periods outside the living memory of residents?" (Soria et al. 2016, pg. 44). We ask a related, but more specific question, namely "How can we communicate the risks of storm surge to a population that has never had any experience of such an event?"

Risk Communication.

The simplest, most basic conceptual framework for risk communication is the classic "source-receiver" model of risk communication, shown in Figure 2 (Shannon &Weaver, 1949; Witt, 1973; Shoemaker, 1987). In this classic model, the goal is simply to transmit, with as great a degree of fidelity as possible, a message from originator to recipient. As considerable research in recent decades has proven, however, such a model is overly simplistic. Early on, psychological/psychometric approaches to risk cognition revealed that the way people perceive risks (which directly affects behavioral response) can be subject to affective elements like dread or familiarity (Fischhoff et al., 1978; Slovic, 1987; Boholm, 1998), cultural scripts (Rayner &

149 Cantor, 1987; Douglas & Wildavsky, 1983), and decision heuristics and biases (Kahneman &
150 Tversky, 1984; Dawes & Kagan, 1988). Other researchers suggest that people also use mental
151 models to organize and make sense of technical risk information (Bostrom, Fischhoff & Morgan,
152 1992; Morgan, 2002). Much of this literature has focused on the cognitive aspect of risk
153 communication.
154
155 Perhaps the most comprehensive treatment of risk communication comes from the research on the
156 social amplification of risk (Kasperson et al., 1988; Renn et al., 1992). In this literature, risk
157 communication is mediated by a host of social, cultural, and other processes, which affect how
158 such communication is received (Pidgeon, Kasperson & Slovic, 2003). Subsequent models extend
159 this by further explicating the manifold processes involved. Yet, whereas the literature cited above
160 has paid more attention to cognitive processes, our research pays closer attention to the
161 organizational processes that mediate risk communication. Organizations process information and
162 meaning through the production of discourse (in text and in speech) that is specific to the
163 organization (Philips, Lawrence & Hardy, 2004; Weick, 1995). This motivates us to focus on how
164 an agency, upon receiving a message (such as a risk signal), then transmits, restates, and
165 embellishes such information –what the organizational literature has referred to as textualization
166 (Taylor et al., 1996) and recontextualization (Iedema & Wodak, 1999).
167
168 Our work shares much with the above conceptual frameworks. Bostrom et al. (2015) also study
169 the hurricane risk communication pathway. Morss et al. (2015), similarly, study communication
170 around flash floods across the entire system (also Lazrus et al., 2015). While these researchers'
171 emphasis is on the cognitive aspect, inquiring into how different stakeholders understand, interpret,

and communicate hazards and risks, our emphasis is on the organizational processing of text --i.e., how organizational routines and cultures affect the communication process. But clearly, these aspects are closely related. As the above researchers note, part of the problem may stem from discrepancies in how different stakeholders understand technical terms and concepts, such as "storm surge". As we discuss below, uncertainty over the meaning of the term storm surge certainly was an issue in Typhoon Haiyan.

Figure 3 depicts a model of risk communication that focuses on the *organizational processing of text*. Information, encoded as text[6], about risks and hazards are not simply transmitted from agency to agency; rather, they can undergo mechanisms of *processing* and *translation*, as these signals trigger different organizational routines, resource mobilization activities, and downstream communication processes within and across a network of agencies. We will refer to this as the *Textual Processing Model* of risk communication. This depiction of organizational processing of text leads us to concentrate on the following questions:

(i) Within the organization, does an agency translate risk signals into the local or agency-specific vernacular (e.g., a disaster risk prevention agency translating a storm surge prediction into implications for evacuation)?

(ii) Across organizations, are there effective, functioning feedback loops between agencies that allow the recipients of a message to verify, clarify, and query the senders about the meaning of the message?

[6] For the purpose of this research, we simply define text as language (written, spoken, or digital) that is or can be transcribed and transmitted as a document. Future work can expand the notion of text to include other vehicles of meaning, such as action or visual elements (Ricoeur, 1971).

iii) To what degree does personal or collective memory of past weather events influence overstating or understating potential impacts?

Specifically, we consider how risk communication for an extreme weather event proceeds after the initial production of technical model output, as was the case with Typhoon Haiyan. In our work, we study how an organization further processes the raw technical information. This means studying whether or not the information is interpreted --in other words, translated into implications for the organization (e.g., triggering different emergency procedures into action) or the public (e.g., evacuation strategies). We observe whether or not the technical information is translated into language that is meaningful to different units in an organization (e.g., terms like "forced evacuation", "emergency procurement", "door-to-door patrolling"). A key question is whether or not organizational routines take the risk information and further process (or fail to process) this knowledge into action, and if agencies exhibit sufficient flexibility and responsiveness, so as to adjust routines to the fit the particular risk situation (e.g., Tompkins, Lemos, & Boyd, 2008).

Figure 3 illustrates an important aspect to the organizational dimension of risk communication – i.e., signals cross organizational boundaries as they are transmitted from agency to agency. Is the signal simply passed on or further translated into terms meaningful to the recipient agency? For example, as the weather forecast information is passed on from a central weather bureau to a risk/disaster management agency, is the information translated into terms that trigger certain risk prevention or emergency response measures by the receiving organization? Does the recipient need further interpretation of what the signal means (e.g., does a 300 kph wind speed imply a different set of scenarios for the responding agencies)?

The literature on boundary processes points to the need for so-called boundary agents who bridge the organizational divide and manage the translation and exchange of information between organizations (Guston, 2001; Levina & Vaast, 2005; Lejano & Ingram, 2009) and, more systemically, chains of boundary organizations or knowledge networks (Feldman and Ingram, 2009; Lemos et al., 2014). And, most critically, disaster risk prevention planning and policy needs to better incorporate lessons learned from decades of risk communication research.

In addition, Figure 3 illustrates the necessary functions of feedback loops (shown in the figure as dashed lines), through which recipient agencies can query, discuss, and exchange knowledge with the sending agency(s) –what some researchers have referred to as dialogic interaction (Moser, 2009). Through these feedback mechanisms, parties can exchange tacit, not just formal, information. Tacit knowledge can include the most meaningful types of advice that formal communication often does not convey. An example of tacit knowledge is when someone tells another to go beyond formal, routine procedures, or when the degree of uncertainty of a forecast is great, an agency may advise another to assume a worst-case scenario that goes beyond the official 'best estimate' forecast. Close coordination, which always involves both formal and informal communication, is a key element in the effective management of extreme events (Comfort & Zagorecki, 2004; Garnett & Kouzmin, 2007).

Focusing on the quality of risk communication has become a central concern of weather and disaster risk reduction agencies in many countries. The efforts of the U.S. NOAA (National Oceanic and Atmospheric Administration), and the National Weather Service which is a bureau

within NOAA, is a prime example, as the agency is trying to reform its communication processes in the light of the experience of such events as Hurricane Katrina and Hurricane Sandy. New storm surge risk maps are being implemented beginning in 2016. Much of the design considerations revolve around appropriate language, such as the more explicit or vivid description of consequences (Morss and Hayden, 2010; Ripberger et al., 2015) or the color schemes used in flood maps (Morrow et al., 2015). Casteel evaluated trial impact-based warnings used by NWS and concluded that richer, more explicit communication about the nature of the hazard and its impacts were effective (Casteel, 2016).

In the succeeding sections, we focus on these particular organizational phenomena (i.e., inter- and intra-organizational translation, and the role of organizational routines) in our discussion of risk communication issues around Typhoon Haiyan.

[Insert Figure 2 around here.]

[Insert Figure 3 around here.]

Methods.

To trace the information pathway, we collected and catalogued artifacts (memoranda, press releases, and others) of the communication process and interviewed key stakeholders in Metro-Manila and Leyte province, including local mayors, members of the national weather bureau (Philippine Atmospheric, Geophysical, and Astronomical Services Administration, or PAGASA), managers of the national and local Disaster Risk Reduction and Management Councils (DRMMCs), and members of the public.

The research team traced the risk communication process sequentially, beginning at the initiation of the message and proceeding down the communication pathway. This meant starting at the national weather bureau, PAGASA, which issues the initial storm/weather forecast. as well as the output of the storm surge and rainfall models. From there, the team traced the message in chronological order, proceeding sequentially along succeeding levels down the communication chain. The second level consisted of the national disaster risk management agency, NDRRMC (National Disaster Risk Reduction and Management Council). From that point onwards, the message travels to regional, provincial, city/municipal, and local district (referred to, in the vernacular, as the *barangay*) levels in sequence. The risk communication pathway was pieced together by interviewing responsible officials at each level and querying each as to the routing of the communication from their office. The interviews were conducted in person.

At each juncture or organization along the pathway, the team collected archival, multi-media evidence showing formal risk communication products, over a four month period (May to August, 2014) in Metro-Manila (the national capital), as well as Tacloban City and surrounding districts. For PAGASA, this consisted of the original weather bulletins issued to the public and wired to lower-level agencies. Artifacts collected included paper or digital copies of bulletins, press releases, fax transmittals, meeting minutes, email messages, as well as digital files consisting of video and audio recordings of press releases, agency briefings, and radio/TV broadcasts.

To gain further knowledge of the risk communication process during Typhoon Haiyan, agency staff were interviewed. We conducted 28 interviews with officials, which were digitally recorded,

transcribed, translated into English from the local languages (Tagalog and Bisaya), and then thematically analyzed. Table 1 summarizes the 28 interviews, of which 6 were at the national, 3 at the provincial, 14 at the municipal, and 5 at the local district levels, respectively. Subjects were recruited by identifying responsible officials in each agency who were tasked with sending or receiving communication regarding the storm event. All of the persons contacted agreed to be interviewed. The interviews began about five months after Typhoon Haiyan. The interviews employed an initial, unstructured open-ended segment, combined with a semi-structured portion involving a series of standard questions. The open-ended segment consisted of asking each informant to provide an account of the risk communication process conducted by their agency, the different message received and sent, along with the media used for sending these messages. The semi-structured portion consisted of asking relatively standardized questions around the risk communication process.

Each interview was initiated with providing information and obtaining consent, including permission to digitally record the interview. Interview recordings were subsequently transcribed for analysis. Analysis consisted of thematic classification, wherein the analyst would read the transcript and highlight key passages that corresponded to the above themes. Table 1 summarizes important themes found in each interview (with an explanation of the themes found in the table footnote).

Two researchers reviewed two of the transcripts and conducted thematic analysis independently to verify inter-coder reliability, which the team judged to be adequate (Krippendorph alpha of

306 0.72). In the analysis below, quotes are English translations, the original text often including
307 combinations of several languages (Tagalog, Bisaya, and English).
308
309 [Insert Table 1 around here.]
310 **Results and Discussion**.
311 It is often the case, as in the Philippines, that already advanced weather forecasting and surge
312 modeling capabilities are not matched by equally effective communication practices. We found
313 that crucial processes of translation and feedback were often inadequate in the case of Typhoon
314 Haiyan. We reconstructed the essential communication pathway, as depicted in Figure 4,
315 beginning with the national weather agency, PAGASA, and continuing on down to line agencies
316 and local governments. Both the archival material and interviews showed that the flow of
317 information was mostly linear and unidirectional, very much corresponding to the pathway shown
318 in Figure 4.
319
320 [Insert Figure 4 around here.]
321
322 The archival information was aggregated to assess how the risk information, specifically focusing
323 on the storm surge model prediction, was transmitted down the communication pathway. Figure
324 5 shows the weather bulletin issued by the national weather agency, PAGASA. The storm surge
325 information is shown as a minor line item yet this event was the most damaging component of the
326 typhoon. At points farther down the communication pathway (e.g. at the provincial or municipal
327 level), we found the message to be essentially a copy of the original. Or, the line agency would
328 issue a cover memo, summarizing information in the accompanying PAGASA bulletin but not

embellishing or interpreting it. For example, the next agency down the risk communication chain, NDRRMC, simply retransmits the same PAGASA bulletin and prepares a shorter summary information sheet (Figure 6). NDRRMC does not add or develop the information in the original PAGASA bulletin. The next level down in the chain is the regional agency, which retransmits the original PAGASA bulletin and prepares its own summary weather advisory (Figure 7). The latter, in fact, contains sparse information, leaving out mention of the storm surge and, instead, warning residents in low-lying areas of possible flooding. This communication is received by the provincial government which, in turn, issues a memo to municipal governments and mayors (Figure 8). As seen in Figure 8, the memo only mentions "possible flash floods and storm surges" without giving any additional information.

[Insert Figure 5 around here.]

[Insert Figure 6 around here.]

[Insert Figure 7 around here.]

[Insert Figure 8 around here.]

The interviews revealed that communication from the regional to the local (city, municipal, barangay) levels were often verbal (through telephone calls), since participants said that many local government offices (especially at the barangay levels) do not have fax machines or reliable internet connections. As the informants described, they would have the PAGASA/NDRRMC advisories in front of them and translate these into the local language (e.g. Waray) while talking to the recipients. It is the same process of automatic translation that PAGASA officials at the regional level said they employed when they read the advisories to give the public updates over

352 the radio. PAGASA's bulletins had but general geographic information to begin with, but the
353 bigger issue seems to be non-embellishment, by provincial and local agencies, of the message with
354 more locally relevant information. In other words, there was little processing of the national agency
355 advisories into more descriptive, contextual, or explanatory text.
356
357 These and other organizational 'rigidities' proved to be a key problem in the communication
358 process. The main findings of our research are as follows.
359
360 *1. Routine, pro forma text fails to transmit meaningful knowledge about singular and*
361 *extraordinary events.*
362 In the case of Typhoon Haiyan, the weather bureau, PAGASA, kept to conventional routine,
363 classifying the storm using its conventional classification scheme, typhoon signal #4, and to "copy
364 and paste" standard text corresponding to that classification in subsequent communication (Figure
365 4). The bulletin's text listing projected impacts was standard, pro forma language for any signal
366 #4 event. The result was the inability to convey information that was distinct from conventional
367 storm-related information regularly received by the public (necessarily distinct, because of the
368 unprecedented nature of the storm surge risk). Such text inadequately communicated how Typhoon
369 Haiyan would be different from what officials and residents had ever experienced in the past,
370 especially with regard to the storm surge. As shown in Figure 4, the modeled storm surge
371 prediction was simply included as a single line of text at the bottom of the weather forecast: a
372 routine, conventional message, as discussed above. Apart from transmitting formal model output,
373 this routine text did not attempt to translate information into meaningful, explicit, and vivid terms

(e.g., "all wooden structures likely to be swept away") that could spur action geared around the ensuing storm surge.

2. The lack of processes of organizational translation resulted in a failure to communicate the severity of risk and the real significance of the storm surge prediction.

By 'organizational translation', we refer to the restatement, explanation, or embellishment of the technical information so that recipients fully understand what it means and what actions are warranted. There was no additional, accompanying explanation that interpreted, for agencies and citizens outside the weather bureau, what the data bulletin and storm surge model output meant. The only translation that occurred was conversion of the English text to the local vernacular, but little or no additional explanation was attempted by any of the agencies, as the official communication from PAGASA was treated as a formal, legal/technical document. Examination of documents from lower-level agencies revealed that what these agencies did, essentially, was to simply copy or report verbatim, in their own communications, the weather bureau's (PAGASA's) originating bulletin without comment or exposition.

When asked why they did not embellish or interpret the storm surge and other items in the bulletin, the disaster management agency official said: "PAGASA says, 'We are the only ones with the authority to announce such information (interpreting) the weather condition.' If you put out your own information, that's not official." On the other hand, when asked the same question, the PAGASA officer replied: "We don't do that (give advice). We are just in charge of creating warning bulletins… we are the warning agency… We don't interpret the bulletins… But if they ask for advice, maybe we can give advice."

This resulted in the absence of interpretation as to what the forecasts meant in real, concrete terms. It was evident from multiple interviews that there was a critical gap in communication, especially that between the national weather bureau, which saw its mission as limited to the rote transmission of modeled forecast output, and the agencies down the line which chose not to engage in interpretation/translation of the official forecasts into terms that would be meaningful to local actors. This is one important reason that the fragment of text, indicating a storm surge of up to 7 meters, located at the bottom of the bulletin, aroused inadequate concern and insufficient action.

This also contributed to the lack of responsive, reflexive action around the storm surge prediction. For example, one informant from the local disaster management agency said that there was no modification of the conventional evacuation routines in response to the risk of storm surge. Evacuation centers along the coast were utilized as before.

The weather and disaster management agency staff also displayed a relatively circumscribed, technical understanding of what constituted valid knowledge and expert advice. Interviewees generally acknowledged that more definite advice might have been given to coastal communities. But several of them thought that, unless the storm surge model became more sophisticated and precise in its modeling capabilities, such that it would pinpoint which communities would or would not be inundated, and to which depths –that they should not offer any additional advice. This coheres with the classic Weberian notion of expert agencies which confine their expertise to the narrowest, technical domains, where staff are highly risk-averse vis-à-vis overstepping their

419 bounds. The interviews indicated an ever-present fear of triggering a false alarm, echoing findings
420 in the literature (Dow and Cutter, 1998).
421
422 *3. Highly routinized and hierarchical lines of communication prevented the transmission of tacit*
423 *knowledge, the latter being needed to guide action.*
424 The communication process consisted of simply passing on the same copy text down the chain of
425 command, without embellishment, addition, or explanation. The communication was largely
426 formal and linear, not allowing for other forums (informal or otherwise) that would allow the
427 transmission of tacit knowledge. Tacit knowledge is what is sought when someone asks a question
428 like: "We see reference to model output indicating a 7 meter surge, but what does this *really*
429 mean?"
430
431 Multiple interviews revealed how routinized and strongly hierarchical the chain of communication
432 was. When we asked the local PAGASA team in Tacloban City, why they stayed in their nearshore
433 office despite the storm surge prediction, the answers were: they were never told by superiors that
434 they could leave the office, and the forecast seemed on the surface to be the same conventional
435 message for category four typhoons, with which they were familiar. When asked why they did
436 not leave the office, the response was: "That [decision] has to come from the central office". In
437 explaining their inattention to the storm surge prediction, the local agency informant said:
438 "Concerning the storm surge, if you imagine the bulletin, the storm surge item appears at the
439 bottom of every bulletin. Every bulletin will have it –regardless of whether it is a depression, storm,
440 or typhoon. Even a depression will have a storm surge notice… so we did not focus on that and
441 instead focused on the extraordinary strength [wind velocity] of the typhoon." They did not ask

higher-level agency members what the storm surge prediction meant in their particular situation. This proved tragic, as of the four on-duty officers at that station, only three survived.

We interviewed communication officers from both PAGASA and NDRRMC who might conceivably act as boundary agents, responsible for translating messages into meaningful terms. What we found was the inadequate organizational translation across agency boundaries. When we asked the central office of the weather agency why they did not highlight, expound on, or further explain the storm surge information (e.g., telling nearshore personnel that their offices would be inundated), the response was that of compartmentalized agency functions. "We (PAGASA central office) merely report the model results. It's the job of the local officials to interpret the data." In short, interpreting and enhancing the message never occurred. There was never a translation of the storm surge model output into a meaningful message (e.g., "Nearshore stations should move operations to offices on higher ground."). On the other hand, when we interviewed the disaster management agency (NDRRMC), the response was that their duty did not include interpretation of weather forecasts, simply receiving (and forwarding) it as transmitted. Organizational cultures that do not foster a sense of agency among bureau staff—the capacity of staff to act in an autonomous, responsive manner (Bovens & Hart, 1996)—were also implicated as part of the inadequate risk communication process.

4. Missing or non-functioning feedback loops resulted in a failure to transmit tacit knowledge. Not only did routinized communication processes fail to translate risk signals into meaningful and actionable knowledge, but feedback loops --which might have been used to query message senders about the meaning of the risk signal-- were not effectively utilized.

The absence or non-activation of feedback loops, allowing even informal communication from lower to higher-level agencies, and between citizens and local agencies, was serious. Analysis of records and recollections of even informal briefing meetings showed that transmission of information was formal and unidirectional (i.e., officials transmitting unembellished forecast information downwards). When asked why the weather bureau did not explain, to lower-level agencies and the public what a 7 meter storm surge meant in real terms, the manager from the national PAGASA central office said that the agency was only responsible for issuing the official forecast, and that they volunteered additional advice only when asked. But as another PAGASA official admitted: "…Because no one had asked (for explanation about the storm surge), and everyone (in the agencies) became busy, there was no more communication."

As an example of the overly hierarchical, non-deliberative nature of risk communication, in a pre-event meeting in Tacloban, the Secretary of the Department of the Interior and Local Government informed local agencies that they had until 10:00 a.m. the following morning to complete evacuations. Local personnel, who were aware that the most recent forecast actually predicted the typhoon's landfall in the early morning hours, chose not to correct the secretary. As one of the risk management officers confided, "I could not say anything because the people in the meeting were all higher-ups. They might say, 'Who are you?' " According to one local mayor, this communication failure may have contributed to the large number of casualties.

5. Lacking meaningful, non-routinized risk communication, officials and residents resorted to 'common sense', drawing from personal experience, which can fail during singular events.

Local pre-emptive procedures involved conventional measures corresponding to a signal # 4 storm (on PAGASA's scale). This included evacuating residents to centers, some of which were located near the shoreline. Most of the interviews with agency personnel revealed that, since there was a lack of clarity regarding what the official bulletins meant regarding level of hazard (especially the storm surge), most relied on their common sense, which meant drawing from their store of personal experiences. But, as one of the local agency officials said: "Nothing prepared us for what hit… you cannot visualize what they mean when they predict a storm surge, so you just use your common sense…" However, as the manager of the disaster agency said: "This was beyond expectation… (and) preparation was not sufficient." In short, there was no communication about the inadequacy of conventional procedures and, for all of those involved, this was a singular event for which there was no personal or institutional memory to draw from.

As one local mayor said, "The general understanding, when you say 'a storm surge', is that the water rises, but it does not travel like a tsunami and knock everything down in its way. We've had storm surges before, and the water would just rise… this time, the water receded 200 meters then got thrown back at the town…" Other investigators also implicate the lack of familiarity with the term, storm surge (Chen, Areddy, and Hookway, 2013).

Speaking to the notion of collective "common sense", a few of the interviewees talked about possibly improved communication if PAGASA had used the term, "tsunami" instead of "storm surge", but then quickly added that to modify language in this way would be out of bounds for them professionally. It is evident that the problem lies not just in the terminologies used (de Bruin

510 & Bostrom, 2013), but in the organizational cultures that could not function outside routinized pro
511 forma communications.
512

Conclusion.

While agency capacities for weather forecasting and storm surge modeling may already be extensive, processes for communicating such knowledge may not be as developed. Our focus on the organizational processing of risk information, paying close attention to message translation/intepretation and boundary exchange, has revealed important ways in which risk communication around Typhoon Haiyan was deficient. It is impossible to judge how different organizational cultures and routines might have changed the outcome. It is possible that a typhoon of this unprecedented magnitude might have caused the destruction that it did regardless of any changes in agency routines. However, our research indicates that in the case of Typhoon Haiyan, the routine transmission of technical information failed to convey knowledge that the oncoming typhoon would be a non-routine event requiring unprecedented actions (Lejano, Tan, and Wilson, 2015).

Furthermore, the provision of a standard message, from which none deviate, needs revision. Rather, communication to more local agents needs to be more contextualized and personalized. By contextualized, we mean translating the message to implications for the local community (in the Philippines, this corresponds to the smallest unit of government, which is the barangay). Maps and text should be crafted that pertains directly to each locale. Messages should be addressed to the community/barangay, perhaps in many cases, delivered door-to-door. This increases the likelihood that the recipients understand the message to be immediately relevant to themselves. Hotlines should be established whereby local agencies or community members can call and inquire into the nature of the event directly, within a conversation that is not merely unidirectional. The presence of lines of communication entails what we call boundary agents --PAGASA or other

agency staff who are trained to field formal or informal queries from multiple publics and who are empowered to deviate from a script. Yet another possible way to increase the local relevance of the messages is to designate different zones in a local neighborhood and to send messages regarding which zones are at high risk. These are just some of the ways to interpret risk information in ways relevant to the recipient.

On the other hand, when agencies simply copy and recopy the same stock message, the recipient sees only a script --i.e., a routine message to which she/he need not pay any special attention. Rote transmission and retransmission of a scripted pro-forma text can give the public a (misleading) signal that it is all merely a ritual.

Our interviews revealed a deep reluctance on the part of agency personnel to interpret official data and translate it in terms most immediately meaningful to the public and local officials. One interviewee thought that, unless and until the storm surge model output was sophisticated enough to pinpoint the specific areas where very high wave heights would be experienced, they would not be able to tell the public anything different than what was communicated during Typhoon Haiyan. The research implicates the stifling effect of organizational routines and agency boundaries. Another problem, vis-à-vis the mere recording of storm surge model output into agency bulletins, is what the public policy literature has referred to as the rigid textualization of policy (Lejano and Park, 2015). In this case, the problem lies in the hesitance of agency personnel to go beyond the formal agency text and the routine transmission of technical information.

This speaks to the need to evaluate organizational routines. Organizational cultures are strongly implicated. More than anything, there is a greater need for empowerment of bureau staff to go beyond rigid routines and tailor their messages to the recipient. They need to be encouraged to facilitate two-way exchanges between message sender and recipient, allowing the transfer of tacit, unofficial information without threat of official sanction for informal communication. Risk communication needs to go beyond formal, repetitive routines to a more relational, contextualized exchange (Lejano, 2008). We alluded to a linguistic turn in risk communication --consistent with this, perhaps we can think of risk communication as narration and each actor as a narrator. Narratives need to be plurivocal, wherein the narrator can freely tell the story (which can be the same basic story as everyone else's) but in varying ways depending on the context within which she or he is communicating (Lejano, Ingram, and Ingram, 2013).

While our conceptual model draws upon previous frameworks such as that of the Social Amplification of Risk and Mental Models research, we place a greater emphasis on the processing of language within and across organizations and the effect of organizational routines on these processes. We hope that our work becomes part of a 'linguistic turn' in the research on communicating risks and hazards. We posit that active interpretation and embellishment of the original messages from the central weather agency should be cast in various forms that are easier for local agencies and the public to interpret. Specifically, we would imagine that an effective process would contextualize, personalize, and more vividly describe risks as the message is coursed to more local recipients. In the case of Typhoon Haiyan, we found, at numerous points, a type of organizational rigidity that consigned agency staff to simply duplicating official weather bulletins in their communications.

There should be a concerted approach to identify, through reflective everyday practice but also periodic program evaluation, bottlenecks in the effective use of forecast model output. The literature is clear on the need to focus more closely on organizational capacities, inter-organizational coordination, and communication (Birkmann & von Teichman, 2010; Serrao-Neumann et al., 2015; Oppenheimer et al, 2015). Agents need to actively process risk information, translating it into terms relevant to the recipient agencies and the public. Calling to mind Lyotard's notion of a narrative community, risk communication should involve multiple policy actors, each telling the story in their own ways (Lyotard, 1984). Future work will build upon this Textual Processing Model of risk communication.

While being critical of communication process, we do not lose sight of the professionalism and extraordinary dedication of agency personnel and local government staff in the Philippines, some of whom lost their lives while performing their duties. The problem, as we see it, is institutional, having to do with agency routines that need to be reflected upon and reformed.

How should governments and media communicate the risks due to events that lie outside a region's collective memory (Leiserowitz, 2006; Fischhoff & Davis, 2014)? One thing is clear: unidirectional lines of communication and organizational rigidities need to change, allowing flexible, contingent responses when circumstances are beyond the norm.

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898 **Table 1**. Summary of Interview Data

			Occurrence of Theme in Interview (Y or N)						
Level of Government	Title/Position	Gender	Theme A	Theme B	Theme C	Theme D	Theme E	Theme F	Theme G
National (Disaster Management)	Civil Defense Officer III	M	Y	Y	Y	Y	Y	Y	N
National (Disaster Management)	Civil Defense Officer	F	Y	Y	Y	Y	Y	Y	N
National (Disaster Management)	Administrative Aide III	F	Y	Y	Y	Y	Y	Y	N
National (Weather Agency)	Officer in Charge, Weather Forecasting	M	N	Y	Y	Y	Y	N	Y
Provincial (Disaster Management)	Provincial DRRM Officer	M	Y	Y	Y	Y	Y	N	Y
Provincial (Disaster Management)	Operations Officer, PDRRM Office	M	Y	Y	Y	Y	Y	N	Y
Municipal Government	Vice-Mayor	M	Y	Y	N	Y	Y	N	Y
Municipal Goverment	Mayor	M	Y	Y	Y	N	Y	Y	N
Municipal Government	City Disaster Risk Management Officer	M	Y	Y	Y	Y	Y	N	N
Municipal Government	City Disaster Risk Management Officer	M	Y	Y	Y	Y	Y	N	N
Municipal Government	Communications Officer	M	Y	Y	Y	Y	Y	Y	N
District Government	Barangay Captain	M	Y	Y	Y	N	Y	Y	N
District Government	Councilor	F	Y	Y	Y	N	Y	Y	N
Municipal Government	City Councilor, Officer for Disaster Risk Management	M	Y	Y	Y	Y	Y	N	N
Municipal Government	Vice-Mayor	M	Y	Y	Y	Y	Y	Y	N
District Government	Barangay Captain	M	Y	Y	Y	N	Y	Y	N
District Government	Councilor, Chair of Public Information	M	Y	Y	Y	N	Y	Y	N
Municipal Government	Officer in Charge, Disaster Risk Management	M	Y	Y	Y	Y	Y	Y	N
Municipal Government	Officer in Charge, Disaster Risk Management	M	Y	Y	Y	Y	Y	Y	N
Municipal Government	Executive Assistant III Disaster Risk Management	M	Y	Y	Y	Y	Y	Y	N
Municipal Government	Mayor	M	Y	Y	Y	Y	Y	Y	N
Provincial (Disaster Management)	Asst Regional Director	M	Y	Y	N	Y	Y	N	Y
Municipal Government	Vice-Mayor	M	Y	Y	Y	N	Y	Y	N
District Government	Barangay Captain	F	Y	Y	Y	Y	Y	Y	N
Municipal Goverment	Mayor's Aide	M	Y	Y	Y	N	Y	Y	N
Municipal Government	Field Officer	M	Y	Y	Y	Y	Y	Y	N
National (Weather Agency Field Office)	Officer-in-Charge	M	Y	Y	Y	Y	Y	Y	Y
National (Weather Agency Field Office)	City Administrator	M	Y	Y	Y	N	Y	Y	N

899 Themes: A Lack of further processing/communication of storm surge information. B Lack of informal/tacit feedback loops across agencies.
C Absence of variation of routine due to storm surge forecast. D Personal awareness of storm surge hazard.
900 E Expectation of storm of record magnitude. F Uncertainty over meaning of storm surge forecast.
G Local government has sole responsibility for interpreting forecast.

901

Figure Headings.

Figures

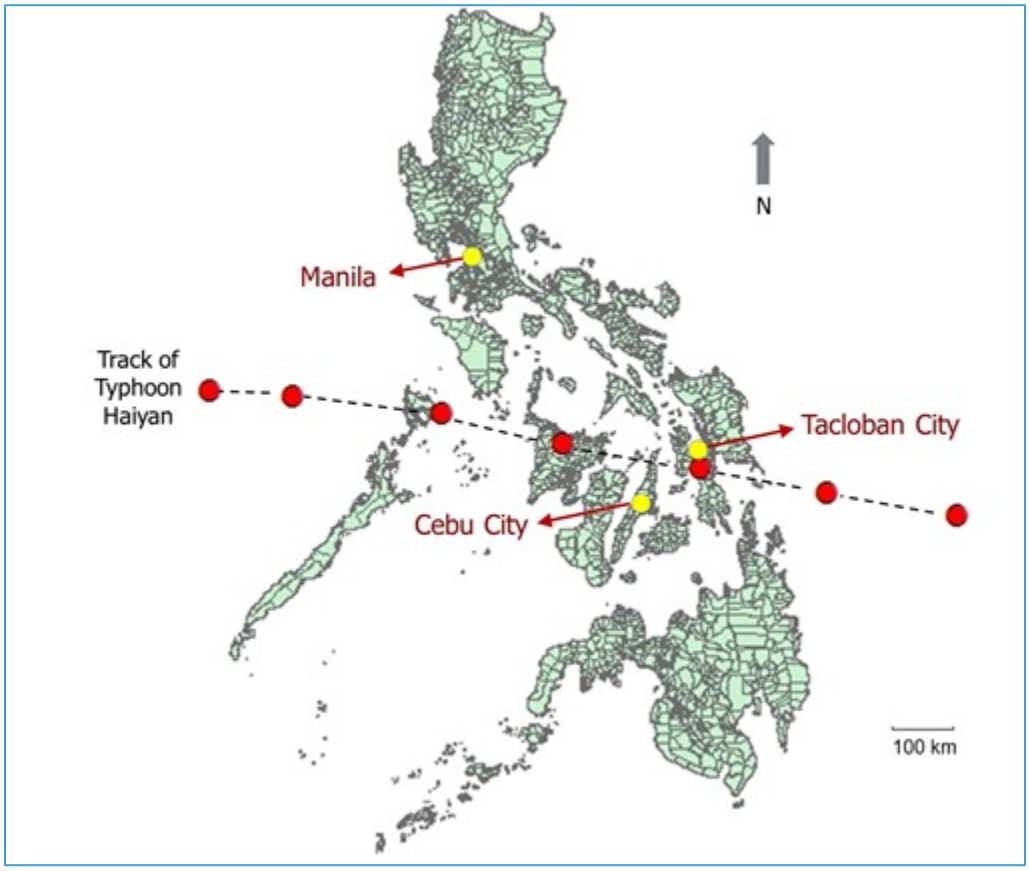


Figure 1. Track of Typhoon Haiyan

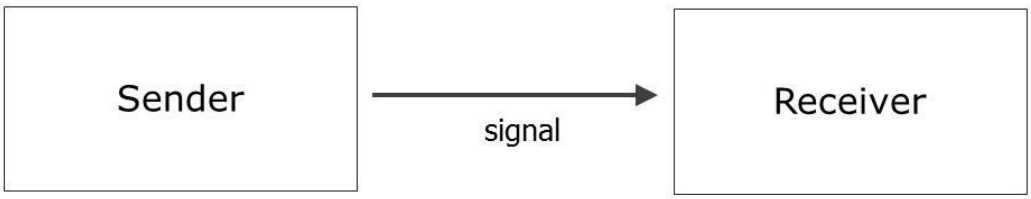


Figure 2. Classic Risk Communication Model

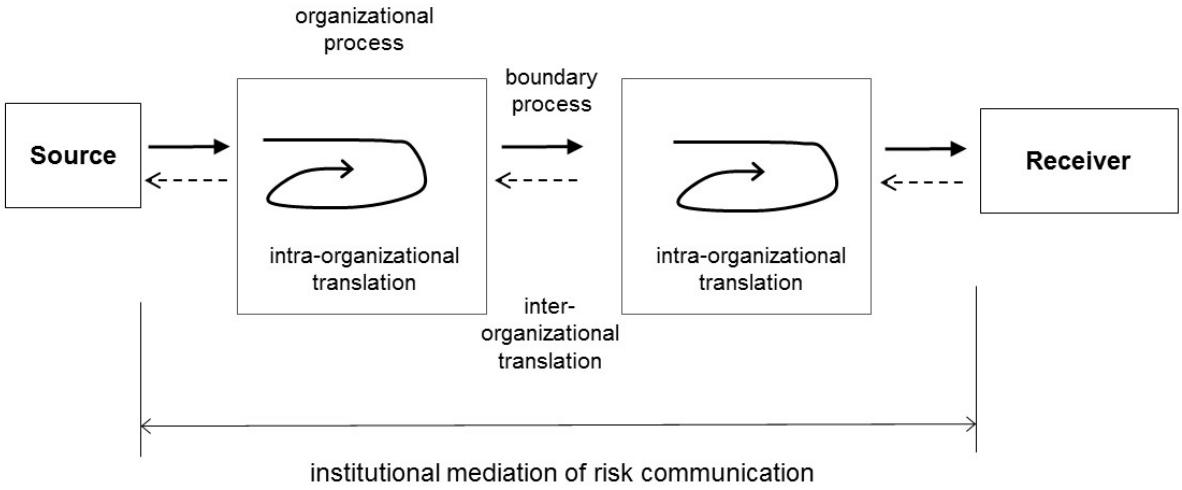


Figure 3. Textual Processing Model of Risk Communication

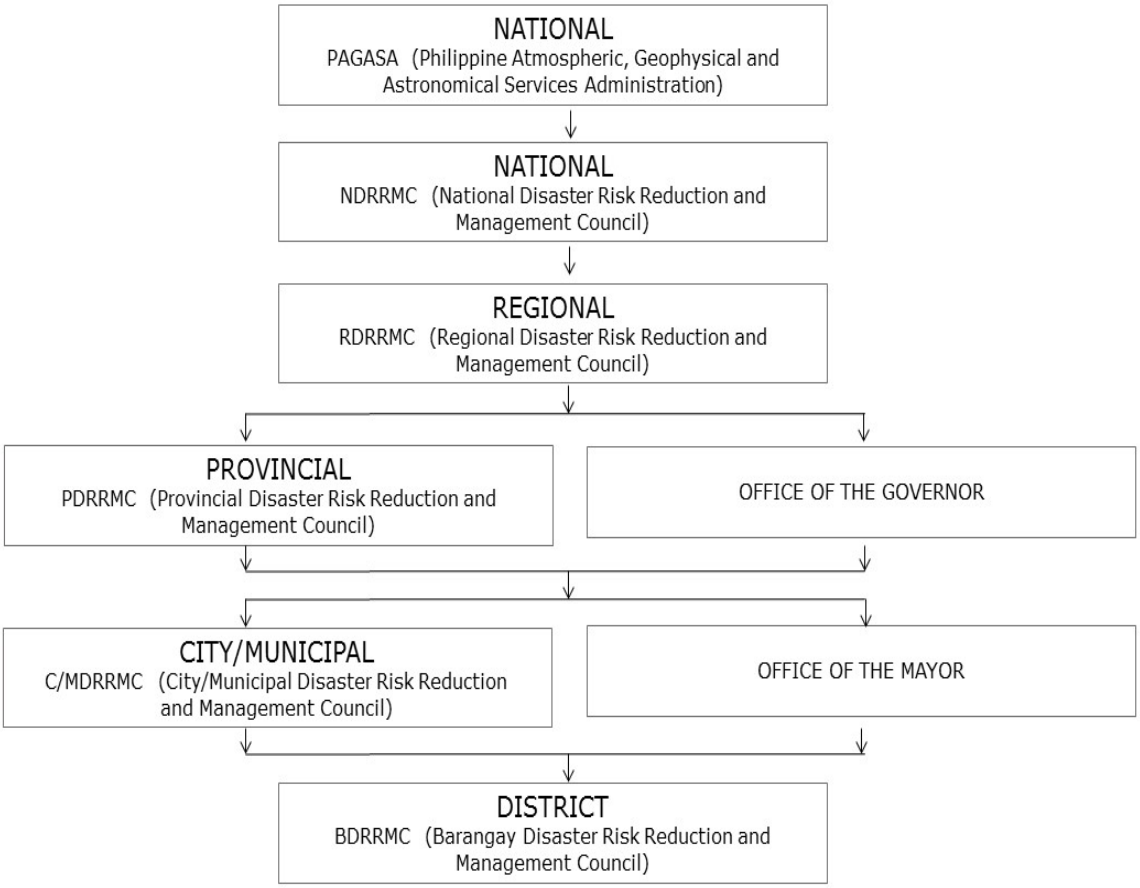


Figure 4. Risk Communication Pathway

TROPICAL CYCLONE WARNING: TYPHOON "YOLANDA" (HAIYAN)
ISSUED AT 8:00 PM, 07 NOVEMBER 2013
(Valid for broadcast until the next bulletin to be issued at 11 PM today)

TYPHOON "YOLANDA HAS ACCELERATED AND INTENSIFIED SLIGHTLY AS IT CONTINUES TO THREATEN EASTERN VISAYAS.

Location of eye/center:	At **6:00 PM** today, the eye of Typhoon **"YOLANDA"** was located based on all available data at **453 km Southeast of Guiuan, Eastern Samar (9.9°N, 129.7°E).**
Strength:	Maximum sustained winds of **225 kph** near the center and gustiness of up to **260 kph.**]
Movement:	Forecast to move **West Northwest** at **39 kph**.
Forecast Position:	Typhoon **"YOLANDA"** is expected to be at **55 km East of Coron, Palawan** by tomorrow evening. By Saturday evening, it will be at **1032 km West of Manila or outside the Philippine Area of Responsibility.**

PUBLIC STORM WARNING SIGNAL

PSWS	LUZON	VISAYAS	MINDANAO	POTENTIAL IMPACTS OF THE WINDS
#4 (Winds of more than 185 kph is expected in at least 12 hrs)		Eastern Samar, Samar, Leyte, Southern Leyte Biliran Province, extreme Northern Cebu including Bantayan Island, Capiz, Aklan, Northern Antique.		• Coconut plantation may suffer extensive damage • Many large trees maybe uprooted • Rice and corn plantation may suffer severe losses • Most residential and institutional buildings of mixed construction material maybe severely damaged • Electrical power distribution and communication services maybe severely disrupted • In the overall, damage to affected communities can be very heavy • The situation is potentially very destructive to communities • All travel and outdoor activities should be cancelled • Evacuation to much safer shelters should have been completed earlier since it maybe too late under this situation

- Yolanda, after hitting Guiuan or Abuyog, Leyte, is expected to traverse the provinces of Biliran, the Northern tip of Cebu, Iloilo, Capiz, Aklan, Romblon, Semirara Island, the Southern part of Mindoro then Busuanga and will exit the Philippine landmass (on Saturday early morning) towards the West Philippine Sea.
- Estimated rainfall amount is from 10.0 - 30.0 mm per hour (Heavy - Intense) within the **600 km** diameter of the Typhoon.
- Sea travel is risky over the seaboards of Northern Luzon and over the eastern seaboard of Central Luzon.
- Residents in low lying and mountainous areas under signal #4, #3,#2 & #1 are alerted against possible flashfloods and landslides. Likewise, those living in coastal areas under signal #4, #3 and #2 are alerted against storm surges which may reach up to 7-meter wave height.
- The public and the disaster risk reduction and management council concerned are advised to take appropriate actions and watch for the next bulletin to be issued at 11 PM today.

7-meter wave height

Figure 5. PAGASA Bulletin (Nov. 7, 2013, 11 pm)

NDRRMC ADVISORY

TO : ALL CHAIRMEN, RDRRMCs, PDRRMCs, OCDRCs I, II, III, IV-A, IV-B, V, VI, VII, VIII, IX, X, XI, XII, CAR, CARAGA, ARMM and NCR

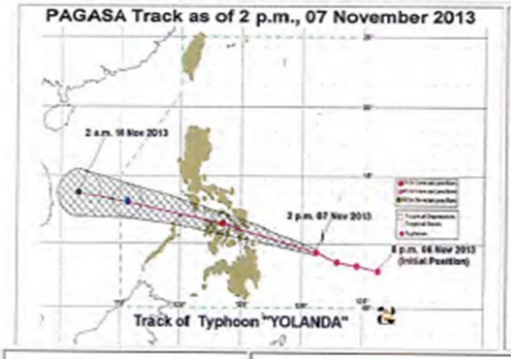
FROM : Executive Director, NDRRMC and Administrator, OCD

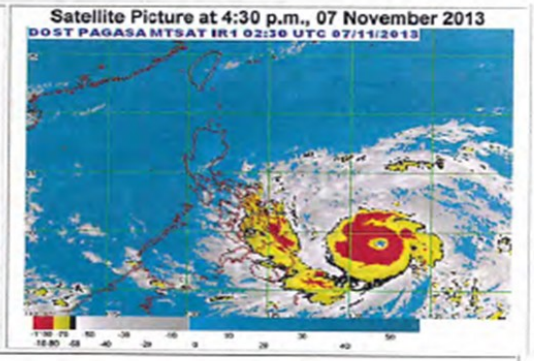
SUBJECT : Severe Weather Bulletin No. 04 re Typhoon "YOLANDA" (HAIYAN)

DATE : 07 November 2013, 5:00 PM

Source: PAGASA-DOST

Typhoon "YOLANDA" has accelerated slightly and has maintained its strength as it continues to threat Eastern Visayas.

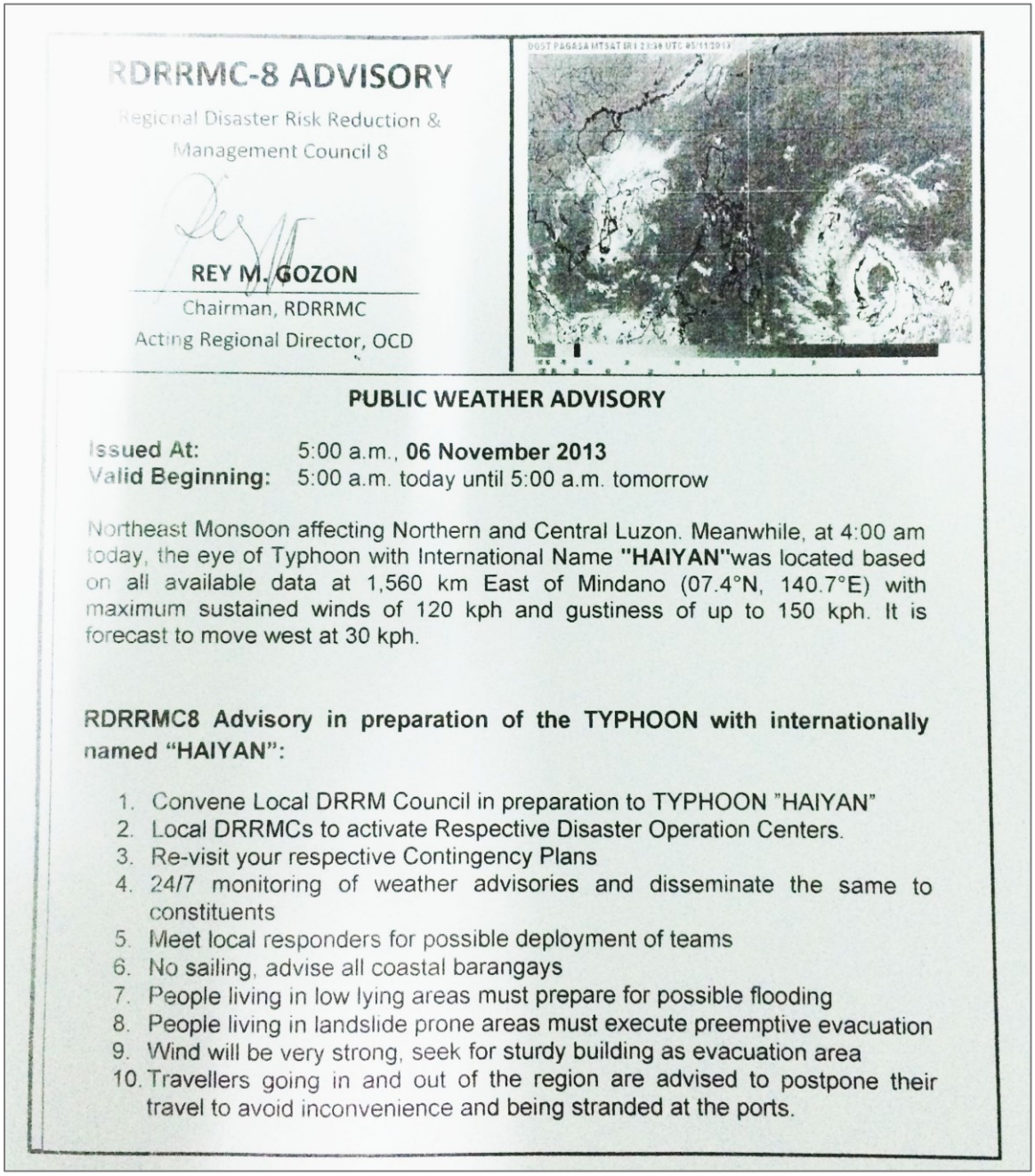




Location of Center: (as of 4:00 p.m.)	**543 km Southeast of Guiuan, Eastern Samar**
Coordinates:	**9.7°N, 130.5°E**
Strength:	Maximum sustained winds of 215 kph near the center and gustiness of up to 250 kph
Movement:	Forecast to move West Northwest at 33 kph

- Estimated rainfall amount is from 10.0 - 30.0 mm per hour (Heavy - Intense) within the 600 km diameter of the Typhoon.
- Sea travel is risky over the **northern and eastern seaboards of Northern Luzon and over the eastern seaboard of Central Luzon.**
- Residents in low lying and mountainous areas under signal #3,#2 & #1 are alerted against possible flashfloods and landslides. Likewise, those living in coastal areas under signal #3 and #2 are alerted against storm surges which may reach up to 7-meter wave height.

Figure 6. NDRRMC Bulletin



RDRRMC-8 ADVISORY

Regional Disaster Risk Reduction & Management Council 8

REY M. GOZON
Chairman, RDRRMC
Acting Regional Director, OCD

PUBLIC WEATHER ADVISORY

Issued At: 5:00 a.m., **06 November 2013**
Valid Beginning: 5:00 a.m. today until 5:00 a.m. tomorrow

Northeast Monsoon affecting Northern and Central Luzon. Meanwhile, at 4:00 am today, the eye of Typhoon with International Name **"HAIYAN"**was located based on all available data at 1,560 km East of Mindano (07.4°N, 140.7°E) with maximum sustained winds of 120 kph and gustiness of up to 150 kph. It is forecast to move west at 30 kph.

RDRRMC8 Advisory in preparation of the TYPHOON with internationally named "HAIYAN":

1. Convene Local DRRM Council in preparation to TYPHOON "HAIYAN"
2. Local DRRMCs to activate Respective Disaster Operation Centers.
3. Re-visit your respective Contingency Plans
4. 24/7 monitoring of weather advisories and disseminate the same to constituents
5. Meet local responders for possible deployment of teams
6. No sailing, advise all coastal barangays
7. People living in low lying areas must prepare for possible flooding
8. People living in landslide prone areas must execute preemptive evacuation
9. Wind will be very strong, seek for sturdy building as evacuation area
10. Travellers going in and out of the region are advised to postpone their travel to avoid inconvenience and being stranded at the ports.

Figure 7. Regional Advisory

Office of the Governor
OFFICE FOR DISASTER RISK REDUCTION and EMERGENCY MANAGEMENT
Child Minding Center Capitol Compound, Cebu City 6000
Tel/fax # (032) 255-0046/255 - 3739

MEMORANDUM

FOR : Mayors/Chairpersons of Local Disaster Risk Reduction and Management Councils

SUBJECT : Public Storm Signal Warning re Typhoon "YOLANDA"

DATE : 07 November 2013

- Forecast from PAGASA Visayas: As of 2040H **PUBLIC STORM WARNING SIGNAL # 4 in Bantayan Island and Exterme Northern part of Cebu. PUBLIC STORM WARNING SIGNAL # 3 in Cebu City and rest of Cebu.**
- All are advised to take precautionary measures against heavy rains, gusty winds, lightning strikes, possible flashfloods and storm surges (for coastal areas).
- Evacuation is highly urged. ANA in risk areas (flood-prone, landslide prone and coastal areas).
- Please submit situational reports to this office as to: (1) Actions Taken (early warning notifications); (2) Effects (area affected, families evacuated, casualties – injured/missing/fatality, infra-agri damage); if no incidents monitored, indicate: NEGATIVE. Fax your report to (032) 255 -0046 and 255 - 3739.

Figure 8. Provincial Advisory